tein-digesting enzyme is added to the fresh egg white. In a few hours it is thin.

These are some of the important things we now know about enzymes, and some of the curious ways in which this knowledge may be twisted to become of industrial value. In general there are two kinds of practical questions—those of stopping enzyme action in dead material you wish to keep whole, and those of maintaining enzyme action on living material you wish to keep alive. The former case concerns the Food Research Division, the latter concerns us all.

I hope ladies and gentlemen that I have not disillusioned you. The living things of 1898 became the unknown catalysts of 1918 and are proteins in 1938. They are still the most mysterious of all substances; the least known; the most powerful; the closest approach to Maxwell's demon that nature seems able to make. We know very little about them yet we have made amazing progress in our knowledge. If you think any of my statements sound fantastic, let me take refuge in the words of the rhetorician Isocrates, written in the fourth century before Christ, "Can anything be supported by stronger evidence than by the oracle of the gods, the assent of many Greeks and the harmony of ancient legend with the deeds of today."

PALEONTOLOGY.—Setigerella *and* Worthenella, *two new subgenera of* Productus.[1] GEORGE H. GIRTY, U. S. Geological Survey.

At the time of this writing probably more than 50 names have been proposed for different groups of the old genus *Productus*. Dunbar and Condra list 42 and a number have since come into the literature. Some of these names are partial or complete synonyms; on the other hand, there are a number of Productoid types that have been overlooked but deserve distinction quite as much as some of those that have been named. These genera, if we may give them that rank, possess different degrees of distinction; they have been differently interpreted and differently classified by different authors, certain ones being considered genera by some, subgenera by others, and of no consequence at all by still others.

I am not wholly sympathetic with the movement which has led to the division of *Productus* into so many genera, but for the time being I would like to cooperate with it in two ways, (1) by using as subgenera under *Productus* the names already proposed where the

[1] Published by permission of the Director of the Geological Survey. Received Aug. 6, 1938.

application of the name seems not open to question, and (2) by naming other subgenera that seem to me to be equally worthy of recognition with those so accepted. If experience proves that the use of these names is not practicable or helpful, it would seem wise to abandon them. As they differ in systematic value, some are more likely to be retained than others. A decision cannot be reached out of hand but only after a period of trial.

Setigerella subgen. nov.

The type species of this subgenus is *Productus setiger* Hall.

The holotype of *Productus setiger* has been figured by both Hall and Stuart Weller, and I also have had the privilege of examining it. The description and figures given by these authors, though adequate in most respects, omit one feature that in my judgment has much significance. The type specimen, which retains both valves in articulation, is flattened on a slab of shaly limestone in such a way as to expose the dorsal valve but conceal all of the ventral valve except the umbonal portion and two tufts of slender spines projecting obliquely outward from the auriculations. The dorsal valve appears to be flat or nearly so over most of its surface, but it is bent upward abruptly about its margin to form a narrow, well defined trail. So far, the facts are of record. The character that I have not seen mentioned is that the marginal part of the dorsal valve is doubled back on itself to form a sort of trough or gutter. The structure recalls in a measure a similar one in *P. wortheni* and *P. marginicinctus*, but it is really essentially different for in those species the marginal part has the form of a ridge or outward-facing arch. A few other characters of the dorsal valve will bear repetition in this place, namely the fine sharp costae which are crossed by obscure concentric plications and the spines which are somewhat sparsely developed over most of the surface but more generously on the auriculations. On this head Weller says "Scattered spine bases occur about as on the opposite valve, [that is, scattered rather generally] increasing in numbers upon the cardinal auriculations."

S. setigera appears to be a rather rare species in the typical region. Weller, for instance, figured only two specimens, the holotype (which shows mainly the dorsal valve) and a somewhat crushed ventral valve from Hamilton, Illinois. I have a small number of specimens (15 or so) from the Keokuk limestone at Keokuk and Warsaw, and as some of these, both dorsal and ventral valves, have a reflexed rim like the type specimen I believe this to be a constant character of the species. It is, of course, a character that would not be shown by immature specimens because it had not yet been developed nor shown by mature ones that were imperfect at the margin. These causes are adequate to explain why some of my specimens from the Keokuk localities do not show the marginal channel.

Setigerella setigera, or a species extremely similar to it, occurs in the Boone limestone of southwestern Missouri and northeastern Oklahoma; only in this area these shells are abundant and many are somewhat larger than any that I have seen from the Keokuk limestone. Some of the specimens examined are testiferous and very well preserved; others occur as molds in fine-grained chert. Molds in any fine-grained material commonly show certain characters more clearly than specimens that retain the shell, for testiferous specimens are usually more or less exfoliated. I propose to

redescribe *S. setigera* from the abundant and well preserved material at my command as a record of the characters shown by the species in an area somewhat removed from the one in which it was first recognized.

Productus (Setigerella) setiger Hall Figs. 1–7

Ventral valve.—Many of the specimens under consideration are somewhat larger than the holotype (and many also smaller), the largest having a width of about 50 mm as against 45 mm for the type. The length measured from the umbo is about equal to the width (slightly more in some specimens and slightly less in others), but if the length is measured from the hinge line the width is much the greater. From these measurements it would be rightly inferred that the umbonal parts project far beyond the hinge when the shell rests upon its aperture. The shape, consequently, is very irregular, the margin having a transversely subquadrate outline interrupted by the backward projection of the umbonal parts which conceal much of the hinge line. The convexity is high, the vault widening rapidly to the anterior margin and having an elongate triangular shape, more rarely quadrate. The sides of the vault descend steeply to the auriculations which are much less oblique and which if not broken are rather large. The cardinal angles are essentially quadrate. Apparently they are in some specimens slightly extended and in others slightly rounded, possibly by accident. A median sinus is a constant feature, though it may be so faint as to be hardly appreciable. More commonly it is rather strong and causes a perceptible emargination in the anterior outline.

The sculpture comprises radial costae, concentric corrugations, incremental lines, and spines. All these features are more or less interrelated in their development and differ in different specimens and on different parts of the same specimen. In the large, the sculpture appears very even and regular, but examined more closely it is seen to abound in small irregularities. The round costae are slender and rather uncommonly sharp in their definition, rising abruptly from rounded striae of about the same width or slightly less. Six or 7 costae are covered by a span of 5 mm, though they are apparently finer on some shells than on others. The spines are small, very numerous and, except for a tuft on the auriculations, rather regularly distributed. They are so small that they affect the costae very little, and as practically all specimens are denuded of them, they are hardly noticeable without a lens. Here and there a costa may bifurcate where a spine makes its appearance, or it may become somewhat elevated behind the spine and depressed in front of it. This last performance is more common over the visceral disc than farther forward, but it is rarely pronounced even there. On the lateral parts where the spines are especially numerous the costae are apt to become irregular and sometimes discontinuous; this heightens the appearance of the spine as arising from an elongated spine base. As already mentioned, a tuft of slender oblique spines is developed on each of the auriculations.

The spines, as in other species of *Productus*, are tubes which communicate with the visceral cavity by means of a small opening, many of which as growth proceeded became closed by deposits of shelly material. On internal molds of *S. setigera* the posterior part of mature specimens rarely shows any evidence of the spines that were dispersed over the exterior, but such evidence is generally distinct over the anterior half or more. On some specimens, presumably old ones, a deposit of shell was apparently laid around the opening of the spines, forming a ring; the internal mold is then pitted with

round holes considerably larger than the spines of which they are the evidence. The concentric corrugations are as a rule strong, regular, and of good size on the sides of the vault, but they rapidly lose strength and regularity in passing across it. Specimens vary greatly in the character of this intermediate region. In some the corrugations are fine, regular, numerous, and faint; in others they are few, strong, and irregular; most, however, show intermediate conditions. It is not practicable to distinguish between mere corrugations and varices of growth; some of the stronger and more persistent corrugations may be varices. The corrugations are not confined to what might be called the visceral disc, though they are strongest in that region. On some specimens they are continued, though with diminished strength, far down the anterior slope. The corrugations become more or less obsolete on the auricles which are thickly covered with small spines. On the sides of the vault where the corrugations are strong, they tend to interrupt the costae, or cause them to be irregular and they also, to a considerable extent, control the distribution of the spines which generally rise from their crests. Well preserved surfaces show incremental lines which, if especially distinct, consist of regular concentric lirae which give the relatively coarse radial costae a crenulated appearance.

Dorsal valve.—This valve is seen to best advantage in the form of external molds in chert for external molds in limestone are more or less covered with shelly material which obscures the surface characters. Dorsal valves in their proper form as concave objects have not come under my observation. As an external mold this valve is of low convexity for the visceral disc is but gently arched and the trail is narrow. The visceral cavity therefore was capacious. The visceral disc and the trail are directed at nearly right angles and are connected by a short strong turn. As the trail approaches the hinge at the side it rather abruptly bends upward, forming a round groove which at the margin is broad and deep, but almost disappears before reaching the beak. The auriculation defined in this way is large, rounded, and very oblique.

The surface characters of this valve are in general like those of the ventral valve. Concentric corrugations are regular, and strong on the sides of the vault but diminish both toward the hinge and away from it. Those near the beak may extend to the hinge; the more lateral ones fall far short of it. Over the intermediate part of the vault the corrugations are much fainter and more irregular varying from specimen to specimen. Small spines are scattered rather liberally over the surface and are especially numerous on the auriculations. It has not been possible to observe this feature on two valves of the same individual, but though actually numerous, the spines

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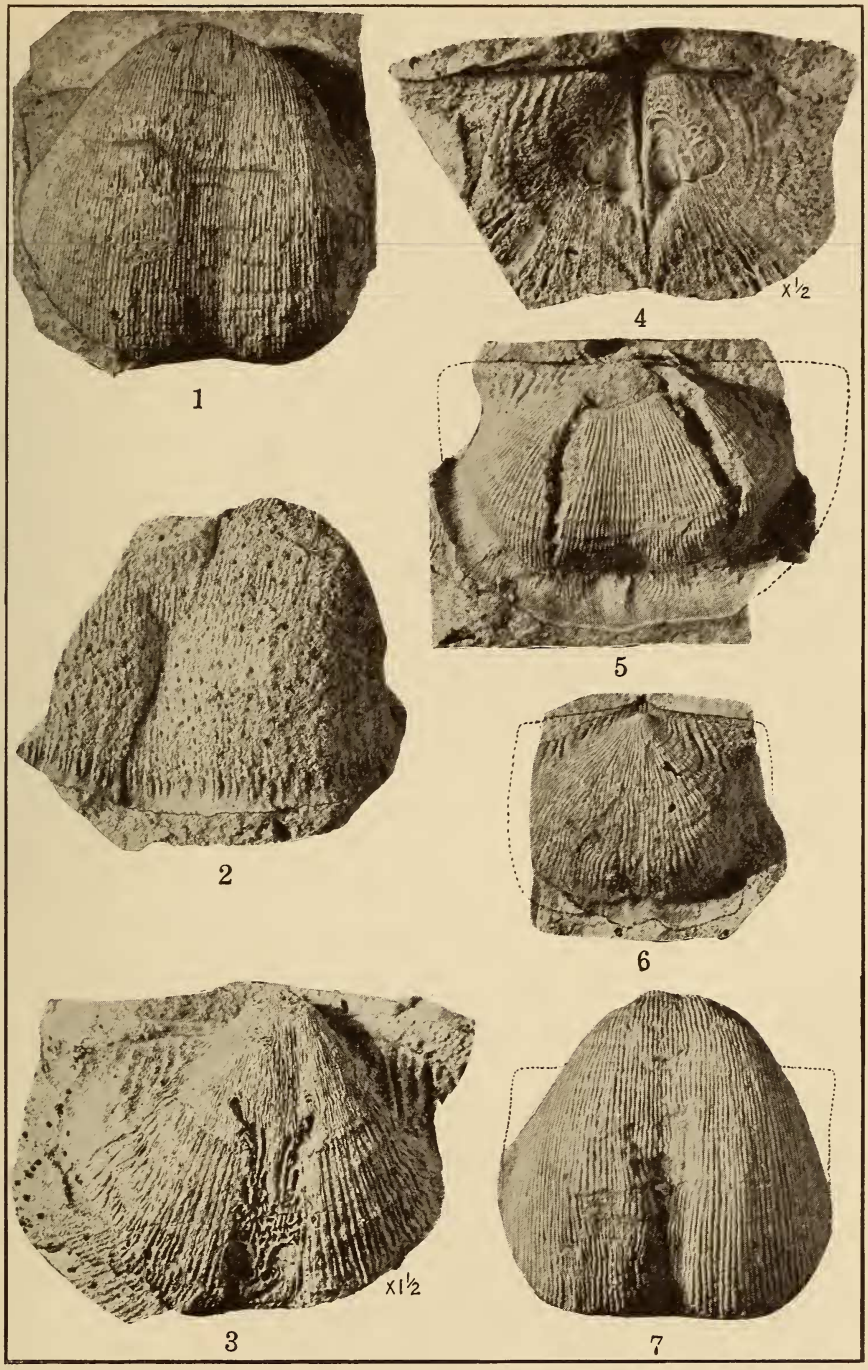
Figs. 1–7.—The localities for originals of these figures are as follows: Fig. 1, residual chert (station 7971), Webb City, Mo.; Figs. 2 to 6, residual chert (station 1310-B), Seneca, Mo.; Fig. 7, near the top of the Boone, on Grand River in the Wyandotte quadrangle, Arkansas (station 4021). All figures except 7 represent molds in chert, fig. 7 represents a testiferous specimen. Fig. 1 represents a large ventral valve which through breakage or non-development lacks the distinctive marginal rim. Fig. 2 represents a crushed ventral valve with the marginal feature as commonly seen. In some ventral valves the marginal rim is extended and upturned. This specimen also shows the pits made by annular deposits around the apertures leading into the spines. Fig. 3 shows the peculiar musculature apparently ending below in two rounded independent scars. Fig. 4 shows the musculature of the dorsal valve. Fig. 5 represents a dorsal valve with a highly developed marginal rim. Fig. 6 represents a smaller specimen also with conspicuous marginal features. Fig. 7 which represents a testiferous specimen can be compared with fig. 1 which represents an internal mold. This specimen also lacks the marginal trough though numerous testiferous specimens retain it.



Figs. 1–7.—*Productus* (*Setigerella*) *setiger* Hall. For description see opposite page.

appear to be appreciably less numerous and perhaps smaller on the dorsal valve than on the ventral valve.

Both valves at maturity exhibit a peculiar feature not as yet described but already referred to as present in the holotype and in other specimens from the Keokuk limestone at Keokuk and Nauvoo. It is indicated by Weller's illustration of the holotype, though not clearly, nor is it mentioned in his description. At maturity the marginal parts of both valves are reflexed to form a very pronounced trough or collar so that a section down the middle would be hook-shaped at the anterior end. This structure varies considerably in detail; it may be broad or narrow, it may be angular or rounded in section, it may be directed outward from the aperture or strongly backward, or it may be even and regular or rather strongly undulating. It seems generally to be more highly developed on the dorsal valve than on the ventral valve.

In the ventral valve the deflection of the marginal part is accompanied by a fairly strong and abrupt thickening of the shell so that internal molds appear also to be constricted at the aperture. The surface of the constriction is uneven, some of the costae becoming obsolete and others maintaining themselves in added size without however extending on to the recurved part. On the outer surface of the collar the radial costae are finer, fainter and more irregular than elsewhere, and over a certain part adjacent to the hinge line they die out completely, that part being marked by crenulating lines of growth such as cover the entire surface. As one would expect, no spines apparently are developed upon the collar.

On the dorsal valve the collar essentially duplicates that of the ventral valve though it commonly appears to be more extensive. The external surface is similarly marked by fine, rather faint radial costae which become obsolete over the parts adjacent to the hinge line so that even the collar, though not defined by any change in direction as it is across the front of the valve, is distinguished from the rest of the shell by a change in sculpture.

Internal structures.—Where these specimens occur in the form of molds, the ventral valve is mostly represented by internal molds and the dorsal valve by external molds for external molds of the ventral valve and internal molds of the dorsal valve are almost always fragmentary, and apt for that reason to be neglected in collecting.

Most of the internal molds of the ventral valve in chert show no distinct muscular imprints; the region where they should occur being marked by fine radial striation much like the rest of the surface. Where shown at all the musculature is somewhat out of the ordinary. It can be observed on a small number of specimens of which the one figured is representative. The other specimens, though differing somewhat in detail agree with that one in essentials. In the figured specimen (Fig. 3) the muscular tract appears to be narrow and elongate. Beginning some distance in front of the beak, it divides posteriorly into two branches and at the anterior end it terminates in two rather large oval scars. The part immediately above the scars especially is covered by an irregular reticulation of thin ridges. The muscular tract as here seen was the seat of the adductor muscles. *Productus* is generally described as having but a single pair of adductor muscles and they are characterized by having a complicated dendritic pattern. Anterior to the dendritic scars, however, an occasional specimen retains the imprint of a distinct and separate pair of scars having an oval shape. Hall and Clarke figure a specimen of "*Productus semireticulatus*" which has an accessory pair of adductor scars (Fig. 17, Pl. 17A). In general plan the imprints of the adductor muscles in that specimen and in this are closely comparable.

Broadly speaking, only exceptional specimens show the musculature of the ventral valve at all clearly, and the scars most commonly preserved are two large fan-shaped imprints made by the diductors, which may have definite outlines but are often distinguishable more by their radial striation. The diductors in the figured specimen of *S. setigera* are also distinguished in that way, but only as a variant from the rest of the surface which is also striated. The scars are sharply defined across their posterior end, partly by being just a little though abruptly depressed, and partly by being abruptly though just a little more coarsely striated. In both respects the scars seem to merge anteriorly with the rest of the surface. Such is their character on the internal mold; on the interior of the valve these features would be elevated. The diductor scars would be slightly though abruptly elevated across their posterior ends and the diductor tract as a whole would stand up still higher.

Of internal molds of the dorsal valve I have, in contrast, only a very few specimens, and here too the musculature appears to show a certain individuality. In *Productus* generally the dorsal valve bears a median septum which divides the impressions of the adductor muscles, these scars being strongly dendritic and rarely distinguishable into anterior and posterior elements. In addition, there are the so-called brachial ridges, which are loop-shaped and extend laterally from the anterior ends of the adductor imprints. This brief summary, I should state, is abstracted from Hall and Clarke. I have two internal molds of *S. setigera* which show the musculature and show it in the same way. The median septum is strongly developed, reaching about half the length of the valve. It is thin and high in the anterior part but as it passes backward it thickens, and becomes a stout ridge which joins a similar stout ridge that borders the hinge line to form a T-shaped figure. From the center of the hinge line, as if a prolongation of the septum, projects the stout cardinal process. The adductor imprints are sharply defined, but my specimens are without evidence of the branchial ridges which, however, can safely be assumed to be potentially present. The adductor scars consist of two subovate or triangular areas which are deeply excavated at the anterior end but only slightly excavated at the sides. The anterior depression is continued forward along the septum in a groove which rapidly becomes narrower and shallower, so that with this included the muscular tract as a whole has a somewhat cordate shape. The lateral and posterior parts of the adductor impressions have the normal vermiculate structure. The oblique anterior outline is somewhat lobate and two lobes on each side of the septum are especially conspicuous. The pair that are adjacent to the septum are so well marked as to suggest that they at least are independent points of muscular attachment. Different figures published to show the interior of the dorsal valve of *Producti* differ materially; the interior of *S. setigera* agrees with some, but not with others.

Almost all authors have shown caution in using internal characters of *Productus* for generic distinction. Some have said that the internal characters show little differentiation. This is perhaps not so true as that the internal characters of a species are not constant in detail and that, in addition, internal characters are so seldom open to observation as to destroy their utility from a practical standpoint. I hesitate to place great reliance upon the constancy or the individuality of the internal characters shown by my specimens of *S. setigera*, as described above.

The shells that I have been identifying with *Productus setiger* are extremely similar to a species that Moore figured as new under the name *P. newtonensis*. In fact, I can hardly doubt that they belong to the same species

in spite of the fact that Moore does not mention some of the characters described above such as the marginal collar, and in spite of the fact that the two forms apparently came from widely separated horizons in the Boone. Moore's species is said to have been found in his Reeds Spring limestone, the horizon of which is some distance below the Short Creek oolite member, whereas my specimens came from 80 feet above the Short Creek oolite. A detailed exposition of this point seems desirable. I have a large collection from the residual cherts at Seneca, Mo., which contains *S. setigera* in abundance. The stratigraphic position of this fauna is of course conjectural. My testiferous specimens from the Joplin district were collected on mine dumps and of those specimens also the stratigraphic position is conjectural. Next, I have two good series of specimens from a whitish limestone in the Wyandotte quadrangle, Okla. One of these was made by Siebenthal and the locality is not at present known to me. The other collection was made by P. V. Roundy and myself, and not improbably came from nearly the same spot as Siebenthal's. The horizon of this collection was thought to be near the top of the Boone, but as we were uncertain whether some overlying beds did not also belong to the Boone the stratigraphic evidence of these two collections is likewise dubious. Finally, I have several collections from some of the higher chert beds of the Boone also in the Wyandotte quadrangle. One of these was made from loose blocks in a plowed field, another smaller collection of the same lithologic character and, so far as it goes, of the same faunal character, was obtained apparently in place from a locality nearby. The horizon of this collection as nearly as could be determined was about 80 feet above the Short Creek oolite member, and the fauna as just said is like the more extensive fauna from the loose blocks in the plowed field which in turn is almost identical with the fauna from the residual cherts of similar character near Seneca. The fauna from the whitish limestone near the top of the Boone is also in accord. There is, however, another angle to this matter. So far as I am aware the identity of the "Short Creek oolite" of the Wyandotte quadrangle with the typical Short Creek oolite near Joplin, has never been established though the presumption is strong that they are the same. If, however, there are two beds of oolite such precision as the evidence seems to possess vanishes, for the stratigraphic position of the Reeds Spring limestone member of Moore is determined with reference to one of them and the position of these specimens of *S. setigera* is determined with reference to the other. Even in that event, however, these specimens of *S. setigera* and the specimens of *Productus newtonensis* apparently come from widely separated horizons in the Boone.

It seems highly probable that the form here under consideration is Moore's *P. newtonensis* and both come from the same general region but from different horizons. On the other hand, I have little doubt that the form under consideration is also identical with typical *S. setigera* which occurs perhaps at nearly the same horizon but in a different region. Moore notes the resemblance of *P. newtonensis* to *S. setigera* but says that it "may be distinguished by its greater average size, its well defined mesial sinus and fold, and the character of the costae." The costae of *P. newtonensis* again are said to be the same in number per centimeter as those of *S. setigera*, but they readily distinguish *P. newtonensis* by "their more angular form, the scattered spine bases which they bear, and the presence of interfurrows broader than the costae." The specimen figured by Moore is considerably larger than most of mine and as already noted, many of my specimens from Oklahoma and Missouri are somewhat larger than my specimens from the Keokuk limestone but they are not much larger than the holotype of *S.*

setigera. On some of my specimens from the Keokuk limestone, the fold and sinus are well developed and in some of my specimens from Oklahoma and Missouri the fold and sinus are faint. The costae on my specimens from Oklahoma and Missouri are rounded, rather than angular and the striae between them are of about the same width. In this they are like many specimens from the Keokuk limestone, but the constancy if not the reality of the difference mentioned by Moore seems to me questionable. I mean that exfoliation in some specimens might readily increase the width of the grooves between the costae and *ipso facto* make the costae appear angular. In the matter of spines the distinction from *S. setigera* which Moore claims for *P. newtonensis* is not clear. He does not mention the presence of spines at all in his description of the ventral valve of that species; in the dorsal valve he says that the costae are "ornamented by the rather numerous irregularly placed spine base nodes." Weller, writing of *S. setigera*, says that spine bases are scattered rather generally over the surface of the ventral valve, at intervals of 5 to 10 mm; on the dorsal valve he notes scattered spine bases about as on the ventral valve increasing in number upon the auriculations. It is probable that Moore merely forgot to mention them, but if spines are really absent on the ventral valve of *P. newtonensis* and abundant on the ventral valve of *S. setigera*, we have a real difference. I doubt whether any such difference exists in this feature between *P. newtonensis* and *S. setigera*, and at all events we are left in doubt on that head.

For the species which I have just described at considerable length I propose the subgeneric term *Setigerella* with *S. setigera* as the type species. One of its distinguishing characters is the reflexed margin which forms a sort of trough about the anterior and lateral rims. It may be objected that this is a character of old age and that old age characters are of no value for generic classification. Both points are open to dispute. The character in question obviously was developed late in the life of the individual but that it is a character of old age rather than a character of maturity would be hard to demonstrate. The fact that it seems to be generally present in unbroken specimens of full size would suggest that it was not a post-mature character. It would also be difficult to demonstrate why an old age character is not of systematic value. If some species developed one sort of old age character, others developed another sort, and still others developed none at all, but just ceased to grow, these facts would unquestionably be significant though how they should be rated is debatable. The practical utility of a character that did not make its appearance until a fully matured stage was reached and that was liable to be lost by marginal breakage is, however, open to challenge, but *S. setigera* can be, and in fact has always been identified as a species on other characters than the one under consideration, and the identification of specimens as belonging to *Setigerella* need not wait upon observation of the marginal trough though according to my experience that structure is present in the majority of specimens. *S. setigera* has other claims to subgeneric rank, one being the abundance of spines on the dorsal valve, a decidedly primitive character; still another perhaps can be found in the muscular imprints, which appear to have some individual features, though the value of this character needs to be further tested as to degree and constancy. Another consideration is that the species does not adjust itself well to other named groups of *Producti*. It is not in accord with the semireticulate *Producti* by reason of its irregular and faint concentric corrugations, which are more or less obsolete except near the hinge line and which are not restricted to a well-defined visceral region but on some specimens continue to be developed on the anterior slope though

rarely with the same strength. The *semireticulati* characteristically have rather coarse radial costae instead of fine ones, a few large spines instead of innumerable small ones, and a spineless or almost spineless dorsal valve. In fact, *Setigerella* is in some respects intermediate between the *semireticulati* and the *ovatus* group (*Linoproductus*). It has the fine lineation of that group and corrugations that are strong near the hinge and vague or obsolete over the vault. But it differs in the geniculate shape of the dorsal valve (*Linoproductus*, however, is not constant in that character), in the very large visceral cavity, and in the great number and small size of the spines, which are distributed over both valves, whereas the tendency in *Linoproductus* is to have a small number of large spines on the ventral valve but no spines at all on the dorsal valve, at least in the more representative species.

There is a possibility that *Setigerella* may conflict with Muir-Wood's genus *Sinuatella*, though this would seem unlikely from her generic description. Licharew[2] remarks that the trail of *Productus* may even be concave and instances *Sinuatella* under which genus (he classifies it, however, as a subgenus) he describes a new species *Productus* (*Sinuatella*) *subsinuatus*. His description and his figures (which are not very distinct and represent only imperfect specimens) seem to show a species that closely resembles *Setigerella* in configuration. The genotype of *Sinuatella* is *Productus sinuatus* de Koninck. Unfortunately the plate (plate 56) on which that species is figured in de Koninck's work is missing from the copy in the Survey Library. Davidson, however, figures a very perfect specimen which has remarkably large and reflexed auriculations. His specimen differs from *Setigerella* in that the feature which they appear to have in common, has just the opposite distribution in each. In *Setigerella* the shell is most extended and recurved in front, the curvature and probably the extension decreasing on the lateral slopes as the auriculations are approached. In *P. sinuatus* it is the auriculations alone that are expanded and upturned; from halfway down the sides the configuration is like that of any other species of *Productus*. In fact, the contrast might be still further enlarged upon for Davidson's figure shows a flattened area extending across the posterior margin of the ventral valve which connects the two large auriculations and from which the vault, divided by a deep sinus, rises rather abruptly. Commenting on the original specimens figured by de Koninck, Davidson says that they were imperfect and that none of them "retained the peculiarly extended and reflexed ears which I have drawn with great care from some very perfect specimens, etc." Muir-Wood does not mention this peculiarity of configuration as characteristic of *S. sinuatus* nor is it shown by her figures. The main distinctive characters of *Sinuatella* (which would otherwise apparently be one of the *semireticulati*) seem to be a well-defined cardinal area in the ventral valve with the delthryium closed by a deltidium, features also mentioned by Davidson and shown by one of his figures. Licharew found a cardinal area in *Productus* (*Sinuatella*) *subsinuatus* but could not detect a deltidium. I am satisfied that *Productus* (*Setigerella*) *setiger* has no real cardinal area and deltidium like those of *Sinuatella*, so that it has neither the configuration nor the structural features of that genus.

Worthenella subgen. nov.

There are two other Mississippian species which are closely related to each other and more loosely to *S. setigera*, all three distinguished in the

[2] Licharew, B. *Permian Brachipoda of North Caucasus.* Pal. U. S. S. R. Monographe **39**: 89. 1937.

mature stages by some remarkable development at the aperture. *Productus wortheni* and *P. marginicinctus* have already been mentioned and are outstanding developments of the Productoid stock in this country. They invite and perhaps deserve subgeneric distinction more than *S. setigera* for their distinctive characters were known even from the first whereas the distinctive characters of *S. setigera* are less striking and have generally been overlooked or unrecorded. If any of our Mississippian *Producti* deserve to be separated from the rest and given a distinctive name it is these two and I propose for them the subgeneric name *Worthenella* with *Productus wortheni* Hall as the genotype. The most distinctive character of *Worthenella* is the arch or fold passing transversely across the shell at the aperture. This development is accompanied by the disintegration of the costae into innumerable fine short spine bases. The objection that might be advanced against using the reflexed rim of *Setigerella* as a generic character would seem to hold almost equally against *Worthenella*. The counter arguments also would be the same and perhaps more telling.

Insofar as I am acquainted with foreign literature, *Worthenella* is a strictly American type. In its final relapse from a costate to a spiniferous condition it recalls *avonia* but *avonia* as originally conceived lacked the marginal arch which is so striking a feature of *Worthenella*, and as redefined it lacks the transition from a costate to a spinose type of sculpture—at least that change which seemed to figure importantly in the original definition, is generally omitted from later ones.

BOTANY.—*New varieties and combinations in* Salix.[1] CARLETON R. BALL, U. S. Department of Agriculture.

Willow collections are steadily accumulating as a result of the efforts of private and public collectors. This makes it possible, from time to time, to evaluate previously described species, especially those based on meager and/or juvenile specimens. It makes possible also the description of variations regarded as worthy of varietal rank. Two new varieties are described, and two new combinations made, in the present paper.

The herbariums in which the specimens examined are deposited are designated by the following abbreviations: CAS, California Academy of Sciences; CNM, Canadian National Museum; CRB, Carleton R. Ball; CUA, Catholic University of America; PC, Pomona College; SU, Stanford University; UC, University of California; UO, University of Oregon; USN, U. S. National Herbarium.

Salix alaxensis (Anders.) Cov. var. **obovalifolia,** n. var.

Folia obovalia vel obovata; petioli breves latique basi dilatata gemmam amplectante.

Shrubs, apparently low, 1-yr. and 2-yr. branchlets stout, 4-7 mm thick, mostly divaricate, densely clothed with yellowish pilose hairs, becoming gray with age; stipules lanceolate, 4–10 mm long, glandular-serrulate or -serrate, pilose; budscales 8–14 mm long, lanceolate to ovate-lanceolate, acute, densely long-pilose; leaves rather crowded on material

[1] Received July 15, 1938.